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Mani Adeli

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application for:

Steve Teig

Serial No.:

Filing Date: 1/14/02

For: METHOD AND APPARATUS FOR ROUTING

Examiner: <not assigned yet>

Group Art Unit: <not assigned yet>

PRELIMINARY AMENDMENT

Assistant Commissioner of
Patents and Trademarks
Washington, D.C. 20231

Sir:

This Preliminary Amendment is concurrently filed with the above-entitled application, which is a continuation application of a presently pending application entitled "Routing Method and Apparatus that Utilize Diagonal Routes," filed on December 7, 2001, and having serial number 10/013,819. **Applicants respectfully request that claims 1-26 be canceled (pursuant to the amendment below) before calculation of the filing fee.**

Please amend the application as follows:

IN THE TITLE

Please replace the current title, "ROUTING METHOD AND APPARATUS THAT UTILIZE DIAGONAL ROUTES," with "METHOD AND APPARATUS FOR ROUTING."

IN THE SPECIFICATION

Please delete the "Claim of Benefit to Prior Application" on page 1, lines 1-11, and insert therein a new Claim of Benefit to Prior Applications as follows:

--CLAIM OF BENEFIT TO PRIOR APPLICATIONS

This application is a continuation application of United States Patent Application entitled "Routing Method and Apparatus that Utilize Diagonal Routes," filed on December 7, 2001, and having serial number 10/013,819. This patent application also claims the benefit of the earlier-filed U.S. Provisional Patent Application entitled "Method and Apparatus that Utilize Diagonal Routes", having serial number 60/325,748, and filed 1/19/2001; U.S. Provisional Patent Application entitled "Routing Method and Apparatus", having serial number 60/314,580, and filed 8/23/2000; and U.S. Provisional Patent Application entitled "Routing Method and Apparatus", having serial number 60/337,504, and filed 12/6/2001.--

Please delete the "Field of the Invention" on page 1, lines 10-12, and insert therein a new Field of the Invention as follows:

--FIELD OF THE INVENTION

The invention is directed towards method and apparatus for routing.--

On page 5, lines 1-8, please delete the "Summary of the Invention", and insert therein a new Summary of the Invention as follows:

--SUMMARY OF THE INVENTION

Some embodiments of the invention provide a method of routing several nets in a region of a design layout. Each net includes a set of pins in the region. In some embodiments, the method partitions the region into several sub-regions that have a number of edges between them. The method (1) for each particular edge, identifies an edge-intersect cost based on a set of potential routes for the nets that intersect the particular edge, and (2) selects routes for the nets based on the computed edge-intersect costs. A potential route for a particular net traverses the set of sub-regions that contain the particular net's set of pins. Also, different embodiments identify different edge-intersect costs. For instance, the edge-intersect cost of a particular edge (1) can be the number of routes that intersect the particular edge, (2) can be a edge-intersect probability that equals the number of routes that intersect the particular edge divided by the total number of routes, or (3) can be a cost derived from the edge-intersect probability. Other embodiments might define other edge-intersect costs.

In other embodiments, the method partitions the region into several sub-regions that have a number of paths between them. The method next (1) for each particular path, identifies a path-use cost based on a set of potential routes for the nets that use the particular path, and (2) selects a route for each net based on the computed path-use costs. Different embodiments identify different path-use costs. For instance, the path-use cost of a particular path (1) can be the number of routes that use the particular path, (2) can be a path-use probability that equals the number of routes that use the particular path divided by the total number of routes, or (3) can be a cost derived from the path-use probability. Other embodiments might define other path-use costs.--

IN THE CLAIMS

Please cancel claims 1-26.

Please add the following claims 27-44.

27. A method of routing a plurality of nets in a region of a design layout, each net having a set of pins in the region, the method comprising:

a) partitioning the region into several sub-regions, wherein a plurality of edges exist between said sub-regions,

b) for each particular edge, identifying an edge-intersect cost based on the number of potential routes for the nets that intersect the particular edge, wherein a potential route for a particular net traverses the set of sub-regions that contain the

particular net's set of pins; and

c) selecting routes for nets based on the computed edge-intersect costs.

28. The method of claim 27, wherein the cost for each particular edge equals the number of potential routes that intersect the particular edge.

29. The method of claim 27, wherein identifying the cost for each particular edge comprises:

identifying an edge-intersect probability for each particular edge, wherein the edge-intersect probability for each particular edge equals the number of potential routes that intersect the particular edge divided by the number of potential routes.

30. The method of claim 29, wherein the cost for each particular edge equals the edge-intersect probability for the particular edge.

31. The method of claim 29, wherein identifying the cost for each particular edge further comprises:

deriving the cost for each particular edge from the edge-intersect probability for the particular edge.

32. The method of claim 27, wherein selecting a route for each net comprises:

a) using the edge-intersect costs to predict congestion of the edge;

b) based on the predicted congestion, selecting routes for nets.

33. The method of claim 27, wherein selecting a route for each net comprises:

a) using the potential routes and the edge-intersect costs to formulate a linear-programming ("LP") problem;

b) solving the LP problem to identify one route for each net.

34. The method of claim 33, wherein the LP problem is an integer linear programming ("ILP") problem, and solving the ILP problem results in an ILP solution that specifies one route for each net.

35. The method of claim 33, wherein solving the LP problem results in a real-number solution for each net, wherein selecting a route for each net further comprises converting the real-numbered solutions to integer solutions that specify only one route for each net.

36. A method of routing a plurality of nets in a region of a design layout, each net having a set of pins in the region, the method comprising:

a) partitioning the region into several sub-regions, wherein a plurality of paths exist between said sub-regions,

b) for each particular path, identifying a path-use cost based on the number of potential routes for the nets that use the particular path, wherein a potential

route for a particular net traverses the set of sub-regions that contain the particular net's set of pins; and

c) selecting routes for the nets based on the computed path-use costs.

37. The method of claim 36, wherein the cost for each particular path equals the number of potential routes that use the particular path.

38. The method of claim 36, wherein identifying the cost for each particular path comprises:

identifying a path-use probability for each particular path, wherein the path-use probability for each particular path equals the number of potential routes that use the particular path divided by the number of potential routes.

39. The method of claim 38, wherein the cost for each particular path equals the path-use probability for the particular path.

40. The method of claim 38, wherein identifying the cost for each particular path further comprises:

deriving the cost for each particular path from the path-use probability for the particular path.

41. The method of claim 36, wherein selecting a route for each net comprises:

a) using the path-use costs to predict congestion of the path:

b) based on the predicted congestion, selecting routes for nets.

42. The method of claim 36, wherein selecting a route for each net comprises:

a) using the potential routes and the path-use costs to formulate a linear-programming ("LP") problem;

b) solving the LP problem to identify one route for each net.

43. The method of claim 42, wherein the LP problem is an integer linear programming ("ILP") problem, and solving the ILP problem results in an ILP solution that specifies one route for each net.

44. The method of claim 42, wherein solving the LP problem results in a real-number solution for each net, wherein selecting a route for each net further comprises converting the real-numbered solutions to integer solutions that specify only one route for each net.

IN THE ABSTRACT

On page 175, lines 1-8, please delete the "Abstract of the Invention", and insert therein a new Abstract of the Invention as follows:

--ABSTRACT OF THE INVENTION

Some embodiments of the invention provide a method of routing several nets in a region of a design layout. Each net includes a set of pins in the region. In some

embodiments, the method partitions the region into several sub-regions that have a number of edges between them. The method (1) for each particular edge, identifies an edge-intersect cost based on a set of potential routes for the nets that intersect the particular edge, and (2) selects routes for the nets based on the computed edge-intersect costs. A potential route for a particular net traverses the set of sub-regions that contain the particular net's set of pins. Also, different embodiments identify different edge-intersect costs. For instance, the edge-intersect cost of a particular edge (1) can be the number of routes that intersect the particular edge, (2) can be a edge-intersect probability that equals the number of routes that intersect the particular edge divided by the total number of routes, or (3) can be a cost derived from the edge-intersect probability. Other embodiments might define other edge-intersect costs. In other embodiments, the method partitions the region into several sub-regions that have a number of paths between them. The method next (1) for each particular path, identifies a path-use cost based on a set of potential routes for the nets that use the particular path, and (2) selects a route for each net based on the computed path-use costs. Different embodiments identify different path-use costs. For instance, the path-use cost of a particular path (1) can be the number of routes that use the particular path, (2) can be a path-use probability that equals the number of routes that use the particular path divided by the total number of routes, or (3) can be a cost derived from the path-use probability. Other embodiments might define other path-use costs. --

REMARKS

This Preliminary Amendment is concurrently filed with the above-entitled application, which is a continuation application of a presently pending application entitled "Routing Method and Apparatus that Utilizes Diagonal Routes," filed on December 7, 2001, and having serial number 10/013,819. In this Preliminary Amendment, Applicants have changed the title of this application, inserted a reference to the related parent application, canceled claims 1-26, added claims 27-44, and replaced the Summary and Abstract. Accordingly, claims 27-44 are currently pending in this application.

Respectfully submitted,

STATTLER, JOHANSEN & ADELI LLP

Dated: 1/14/02

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